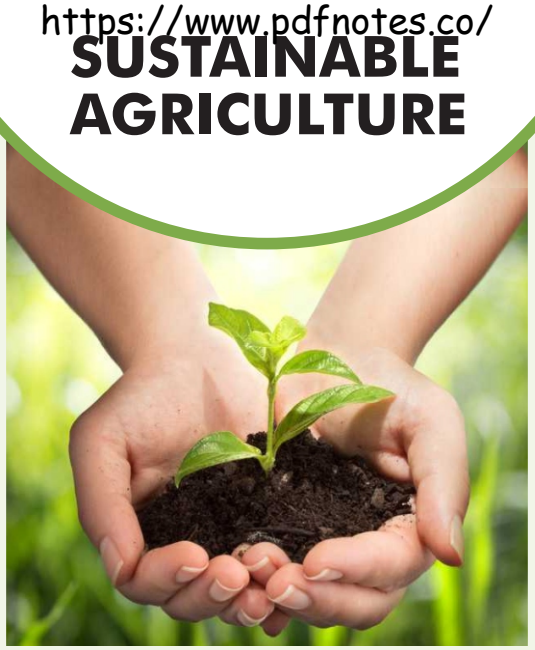
Financial Sustainability



Environmental Sustainability

Social Sustainability

VISIONIAS INSPIRING INNOVATION

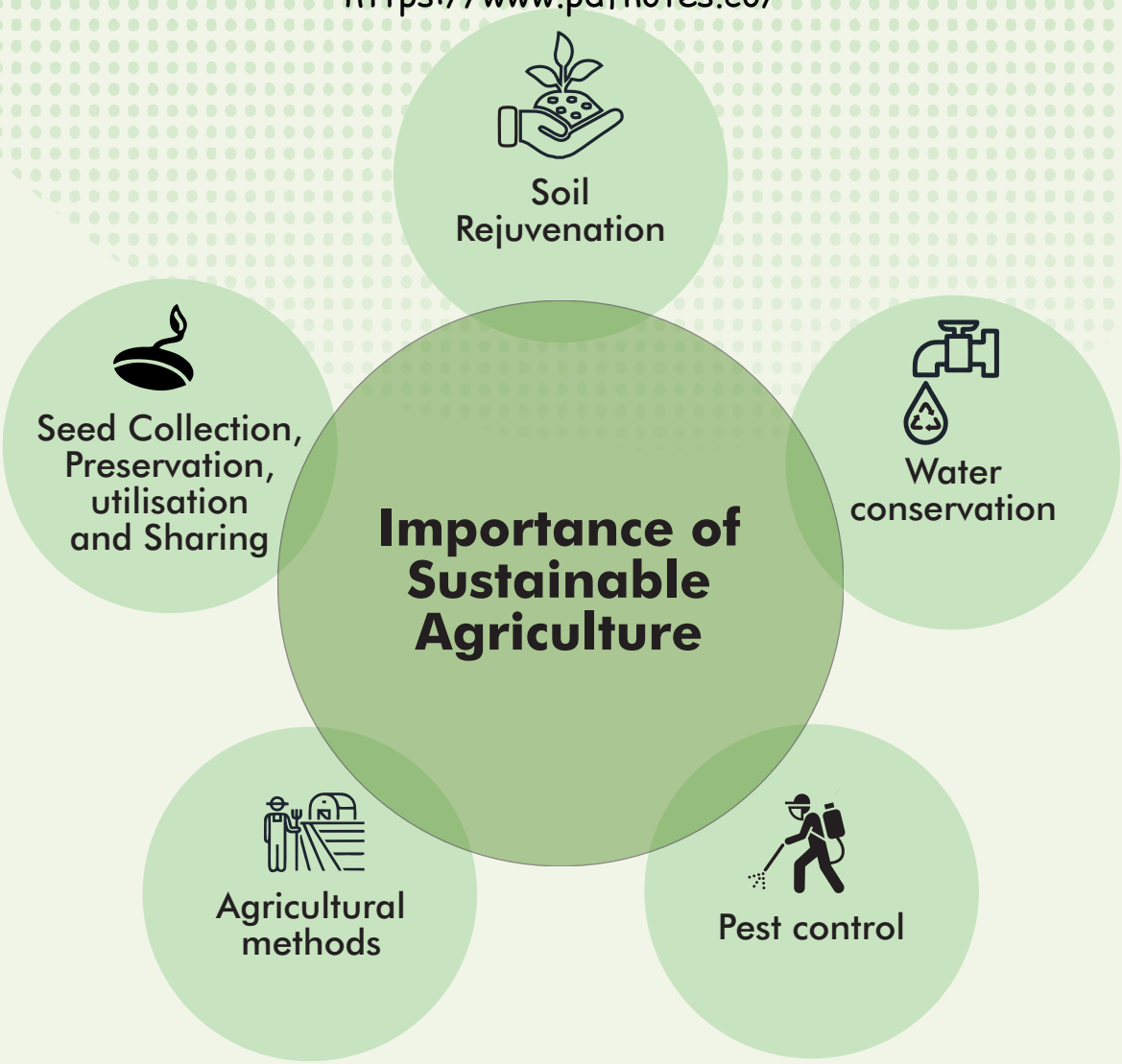
QUICK REVISION MODULE (UPSC PRELIMS 2022)

SUSTAINABLE AGRICULTURE

SUSTAINABLE AGRICULTURE

Sustainable agriculture: an integrated system of plant and animal production practices having a site-specific application that will over the long-term

- Satisfy human food and fiber needs.
- Enhance environmental quality and the natural resource base upon which the agriculture economy depends.
- Make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.
- Sustain the economic viability of farm operations.
- Enhance the quality of life for farmers and society as a whole.



NEED FOR SUSTAINABLE AGRICULTURAL PRACTICES

Currently, many countries face the challenge of wasted resources due to inefficient of practices. Here is how...

- **14%** of global greenhouse gas emissions
- Conversion of **50%** of the world's habitable land into farming land
- Increased pesticide usage by **26 times** over the past 50 years
- Polluted **48%** of stream and river water

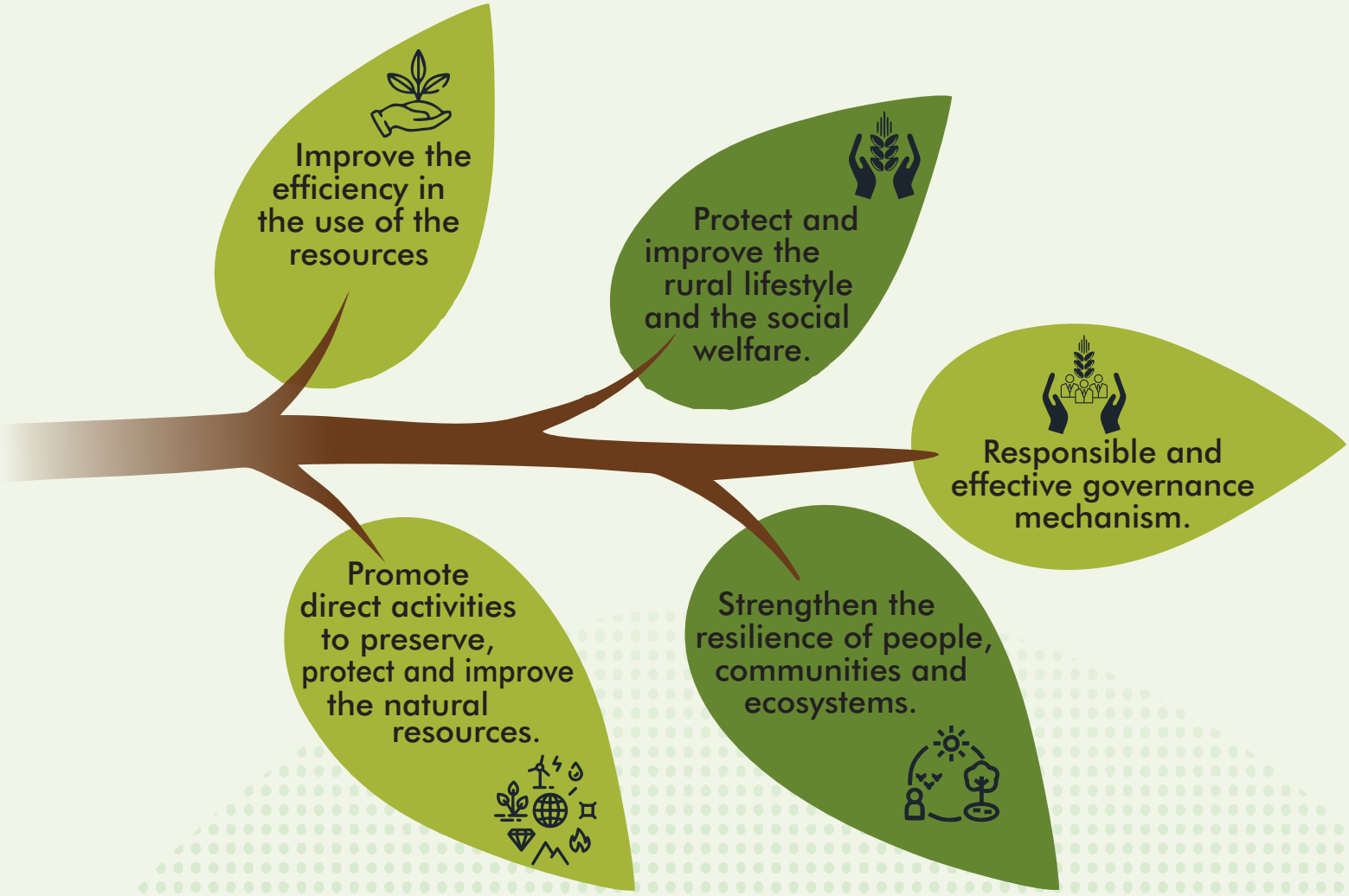
Unsustainable agricultural practices lead to loss of 12 million hectare of land each year to decertification

At this rate by 2050, another 120 million hectares of natural habitates will be lost to farmland

This further strengthens the need for using available resources in the best possible way to minimize the adverse impact on our environment and improve the agricultural productivity by deploying high yielding, water efficient and pesticide resistant seeds.

PRINCIPLES OF SUSTAINABLE AGRICULTURE

The Food and Agriculture Organization of the United Nations (FAO) has established five basic principles for the global agricultural sector to become increasingly productive and sustainable.



With these five principles, FAO aims to create national, regional and global systems that promote sustainability at the social, economic and ambiental levels.

SUSTAINABLE PRODUCTION PRACTICES

Plant Production Practices

- Diversification of crops and culture practice
- Management of soil quality
- Efficient and human use of inputs
- Consideration of farmer's goals lifestyle choices

Animal Production Practices

- Management Planning when including livestock in farming
- Animal Selection, considering the form capabilities and constraints.
- Animal Nutrition including feed quality and monitoring animal health periodically
- Use of good genetic stock and quality germplasm to improve herd performance.
- A herd health program is critical to sustainable livestock production.

SUSTAINABLE AGRICULTURAL PRACTICES

1. Mulching

Mulch is simply a protective layer of a material that is spread on top of the soil. Mulches can either be organic -- such as grass clippings, straw, bark chips, and similar materials -- or inorganic -- such as stones, brick chips, and plastic. Mulching enriches and protects soil, helping provide a better growing environment.

Significance of Mulching

- Protects the soil from erosion

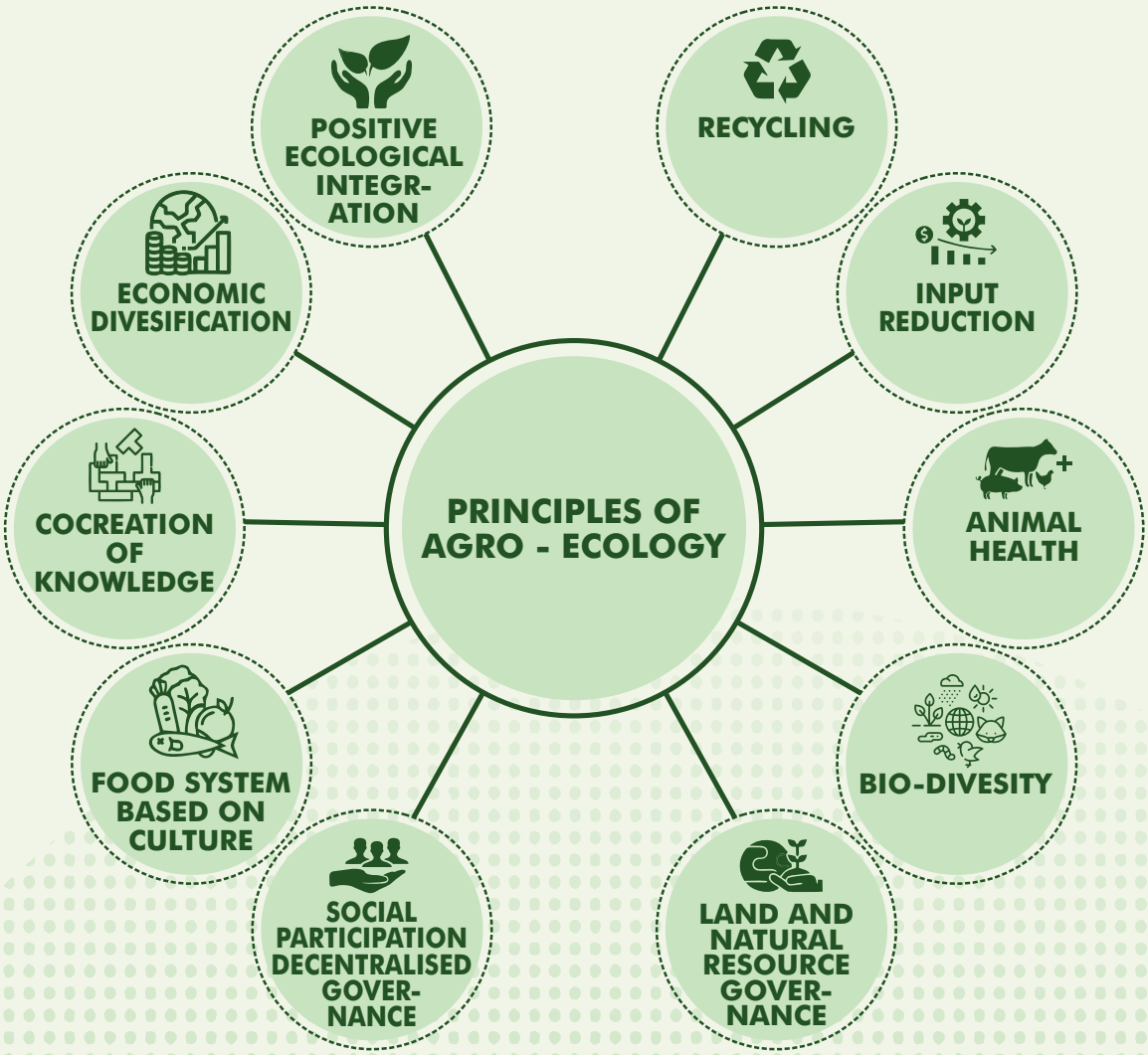
- Reduces compaction from the impact of heavy rains
- Conserves moisture, reducing the need for frequent waterings
- Maintains a more even soil temperature
- Prevents weed growth

2. Zero Tillage

Zero tillage is the process where the crop seed will be sown through drillers without prior land preparation and disturbing the soil where previous crop stubbles are present. Zero tillage not only reduce the cost of cultivation it also reduces the soil erosion, crop duration and irrigation requirement and weed effect which is better than tillage. Zero Tillage (ZT) also called No Tillage or Nil Tillage.

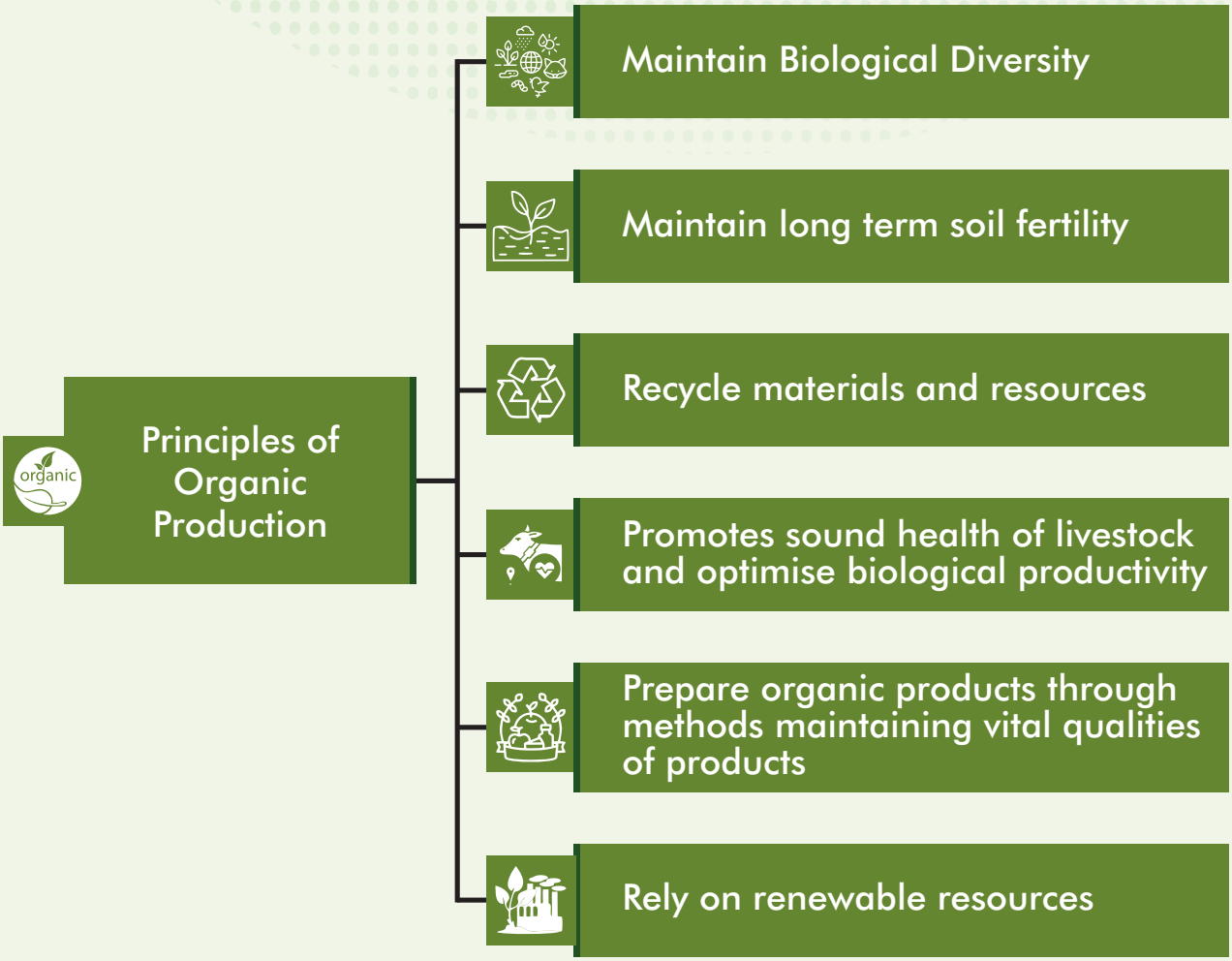
3. Agro-Ecology

Agroecology is an integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of food and agricultural systems. It seeks to optimize the interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system.



4. Organic Farming

A system of farm design and management to create an eco-system of agriculture production without the use of synthetic external inputs such as chemicals, fertilisers, pesticides and synthetic hormones or genetically modified organisms.



Mandatory labeling of Organic food: It should convey full and accurate information on the organic status of the product. There will be penalties on non-compliance of regulation.

Approval authority: Organic food products should carry a certification mark or a quality assurance mark given by

- National Programme for Organic Production (NPOP)
- Participatory Guarantee System for India (PGS-India)
- Voluntary logo from the FSSAI that marked its produce as 'organic.

5. Zero Budget Natural Farming (ZBNF)

It is a natural farming technique in which farming is done without use of chemicals and without using any credits or spending any money on purchased inputs. ZBNF reduces the cost of production down to zero due to utilisation of all the natural resources available in and around the crops. Farmers use earthworms, cow dung, urine, plants, human excreta and other biological fertilizers for crop protection. It has been developed by Subhash Palekar.

CORE PRINCIPLE OF ZBNF

1. DEEJAMRUTHAM: Microbial seed coating through cow urine and dung based formulations.

2. JEEVAMRUTHAM: enhance soil microbiome through application of cow dung, cow urine and other local ingredients

3. COVER CROPS AND MULCHING: Ground to be keept covered with crops and also crop residues

4. WAAPHASA Fast build up of soil humus through ZBNF leads soil aeration

6. Intensive Agricultural Practices

Intensive farming practices which are thought to be sustainable have been developed to slow the deterioration of agricultural land and even regenerate soil health and ecosystem services. These developments may fall in the category of organic farming, or the integration of organic and conventional agriculture.

- **Pasture cropping** involves planting grain crops directly into grassland without first applying herbicides. The perennial grasses form a living mulch understory to the grain crop, eliminating the need to plant cover crops after harvest. The pasture is intensively grazed both before and after grain production. This intensive system yields equivalent farmer profits (partly from increased livestock forage) while building new topsoil and sequestering up to 33 tons of CO 2/ha/year.

- **Biointensive agriculture** focuses on maximizing efficiency such as per unit area, energy input and water input.

- **Agroforestry** combines agriculture and orchard/forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems.

- **Intercropping** can increase yields or reduce inputs and thus represents (potentially sustainable) agricultural intensification. However, while total yield per acre is often increased, yields of any single crop often diminish. There are also challenges to farmers relying on farming equipment optimized for monoculture, often resulting in increased labor inputs.

- **Vertical farming** is intensive crop production on a large scale in urban centers, in multi-story, artificially-lit structures, for the production of low-calorie foods like herbs, microgreens, and lettuce.

7. Permaculture

Permaculture is an innovative framework for creating harmonious integration of landscape and people- providing their food, energy, shelter, and other material and non-material needs in a sustainable way. The term was coined by Bill Mollison in 1978.

Significance of Permaculture

- Environment friendly: It discourages uses of chemical and pesticide and promotes the uses of eco-friendly means to maintain soil health and increase productivity.
- Decrease Global warming: Increasing area under permaculture from current 108 million acres to 1 billion acres by 2050 could result in a total reduction of 23.2 gigatons of CO_2, from both sequestration and reduced emissions.
- Promotion of Traditional practice: It incorporates traditional farming practices with modern technological and scientific knowledge to create efficient systems. It can also reduce the dependency of farmers on multi-national companies for genetically modified seeds.
- Improve income: Instead of monoculture, permaculture uses polyculture where a diverse range of vegetation and animals are utilised to support each other to create a self sustaining system.

8. Vertical Farming Systems

Vertical farming is cultivating and producing crops/ plants in vertically stacked layers and vertically inclined surfaces. In 1915, Gilbert Ellis Bailey coined the term "vertical farming".

Advantages of vertical farming

- High productivity per unit area i.e. almost 80% more harvest per unit of area.
- Production throughout the year without the risk of vagaries of nature
- Reduces the transport cost
- 70 to 95 % less water utilisation compared to traditional farming
- 90%less or no soil is needed and thus no pest and disease
- Infestations so organic food is produced.
- Fresh produce with all its original nutrient qualities.
- Help in greening of the urban areas and help to reduce the rising temperatures and mainly the air pollution in cities.

Disadvantages of vertical farming Initial high cost

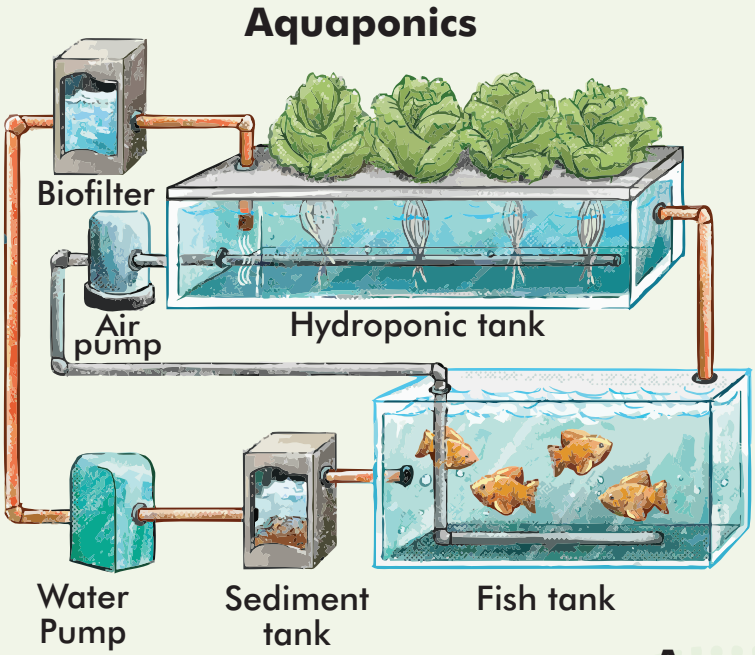
- High energy cost as growing plant is entirely with artificial lights.
- The excess nutrients used in vertical farming may interfere and contaminate the main urban water system if not taken care of.
- LED lighting systems emit heat though small amount will create problem of maintaining the temperatures especially in summer months and may overload the air conditioning systems which will again incur high energy cost
- Lot of garbage, plant residues, etc. will be generated around the buildings with vertical farming which needs to be dispose off properly.
- Skilled workforce is needed

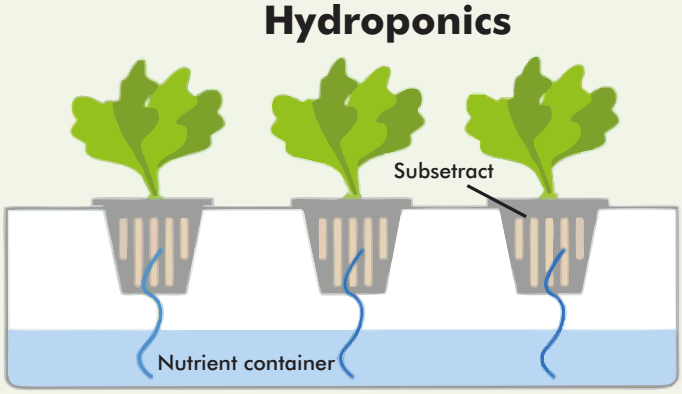
Systems of Vertical farming

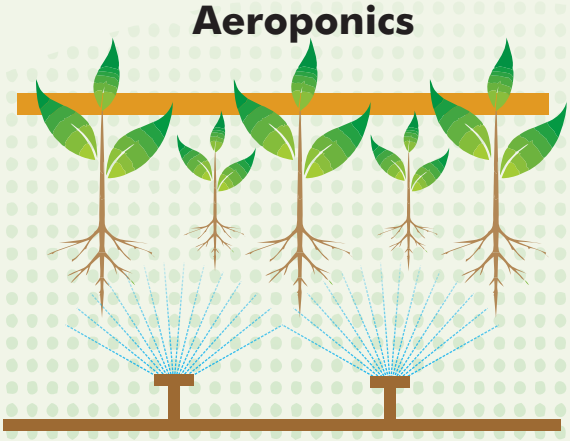
1. **Hydroponics:**
   - It is a method of growing food in water using mineral nutrient solutions without soil. The basic ges of this method is that it reduces soil-related cultivation problems like soil borne insects, pest and diseases.

2. **Aeroponics**
   - In aeroponics, there is no growing medium and hence, no containers for growing crops. In aeroponics, mist or nutrient solutions are used instead of water. As the plants are tied to a support and roots are sprayed with nutrient solution, it requires very less space, very less water and no soil.

3. **Aquaponics**
   - It is a bio-system that integrates recirculated aquaculture (fish farming) with hydroponic vegetable, flower, and herb production to create symbiotic relationships between the plants and the fish.
   - It achieves this symbiosis through using the nutrient-rich waste from fish tanks to "fertigate hydroponic production beds. In turn, the hydroponic beds also function as bio-filters that remove gases, acids, and chemicals, such as ammonia, nitrates, and phosphates, from the water.
   - Simultaneously, the gravel beds provide habitats for nitrifying bacteria, which augment the nutrient cycling and filter water. Consequently, the freshly cleansed water can be recirculated into the fish tanks.







9. Integrated Pest Management (IPM)

IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

Components of IPM

- Pest identification.
- Monitoring and assessing pest numbers and damage.
- Preventing pest problems.
- Using acombination of biological, cultural, physical/mechanical and chemical management tools.
- After action is taken, assessing the effect of pest management.

Approaches for managing pests are often grouped in the following categories.

- **Biological control:** It is the use of natural enemies— predators, parasites, pathogens,and competitors —to control pests and their damage.
- **Cultural controls:** These are practices that reduce pest establishment, reproduction, dispersal, and survival. For example, changing irrigation practices can reduce pest problems, since too much water can increase root disease and weeds.
- **Mechanical and physical controls:** It kills a pest directly, block pests out, or make the environment unsuitable for it. Traps for rodents are examples of mechanical control. Physical controls include mulches for weed management, etc.
- **Chemical control:** It is the use of pesticides. In IPM, pesticides are use only when needed and in combination with other approaches for more effective, long- term control. Pesticides are selected and applied in a way that minimizes their possible harm to people, non-target organisms, and the environment.

Sustainable Development

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Sustainable Agriculture

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Integrated crop Management

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Integrated Pest Management (IPM)

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Basic Components

- Prevention
- Crop rotation
- Cropping pattern
- Seed Selection
- Fertilisation and Irrigation
- Inter-cropping
- Harvesting and storage

Technologies and Service

- Improved Crop vanities through genetic enginnering
- Disease control through biopesticides
- Insect control through pheromones
- Erosion control through cover crop management no tillage etc.

IPM Implementation

- Education and Training
- Multi-stakeholder partnership including private sector, scientists etc
- Technology transfer and capacity building of framers.

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Observation

- Crop monitoring
- Decision support Systems
- Area Wide Management

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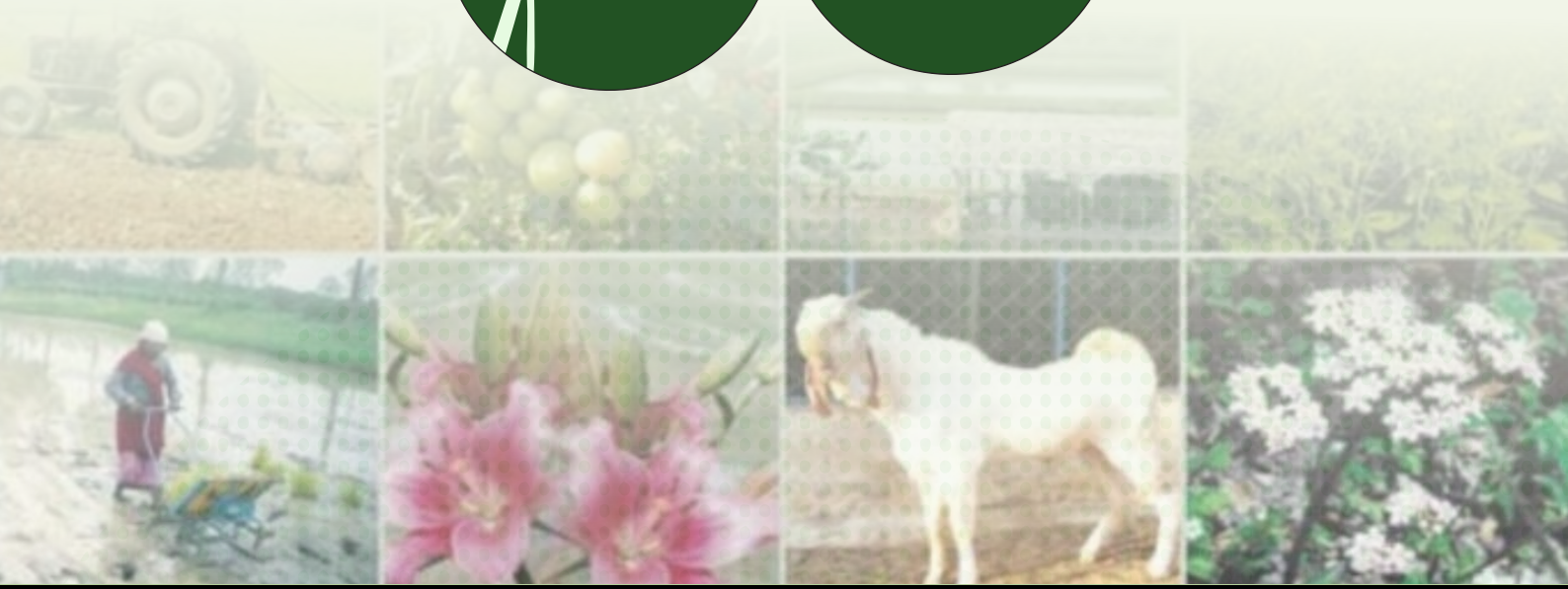
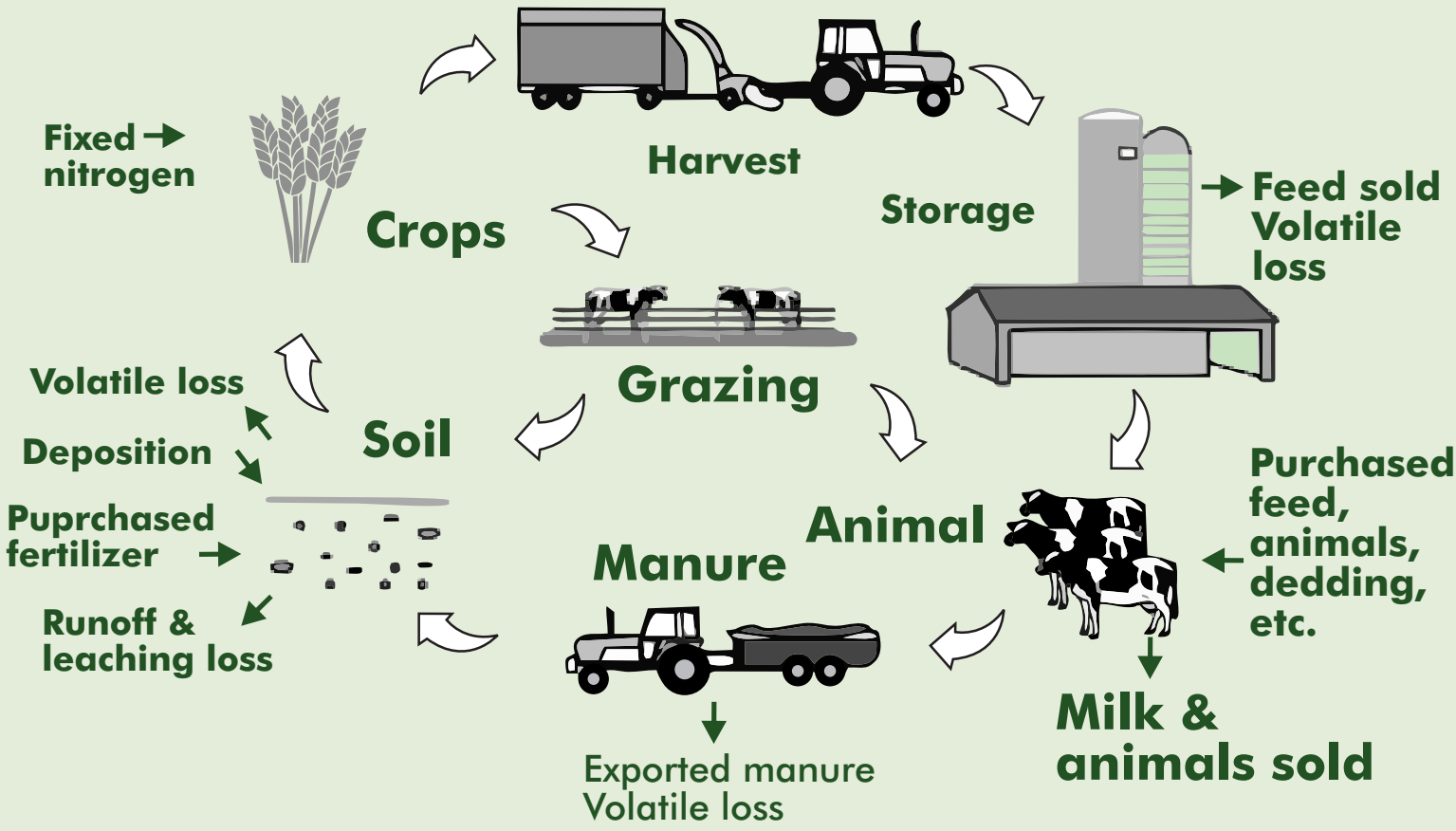
Interventions

- Cultural and Physical Control
- Biological Control
- Chemical Control

10. Integrated Farming System (IFS)

Integrated Farming System is the integrated crop production with livestock management which in a way complements each other with a nice symbiotic relationship which at the time is economically viable and profitable, environmentally suitable, and benefit giver of diversification of production.





Process of Integrated Farming system

GOVERNMENT INITIATIVES

1. National Mission on Sustainable Agriculture

It aims at making agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific integrated /composite farming systems; soil and moisture conservation measures; comprehensive soil health management; efficient water management practices and mainstreaming rainfed technologies.

NMSA will have following objectives:

- To make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific Integrated/Composite Farming Systems;
- To conserve natural resources through appropriate soil and moisture conservation measures;
- To adopt comprehensive soil health management practices based on soil fertility maps, soil test based application of macro & micro nutrients, judicious use of fertilizers etc.;
- To optimize utilization of water resources through efficient water management to expand coverage for achieving 'more crop per drop';

- To develop capacity of farmers & stakeholders, in conjunction with other ongoing Missions e.g. National Mission on Agriculture Extension & Technology, National Food Security Mission, National Initiative for Climate Resilient Agriculture (NICRA) etc., in the domain of climate change adaptation and mitigation measures;
- To pilot models in select blocks for improving productivity of rainfed farming by mainstreaming rainfed technologies refined through NICRA and by leveraging resources from other schemes/Missions like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Integrated Watershed Management Programme (IWMP), RKVY etc.; and
- To establish an effective inter and intra Departmental/Ministerial co-ordination for accomplishing key deliverables of National Mission for Sustainable Agriculture under the aegis of NAPCC.

Different strategies for implementation of National Mission for Sustainable Agriculture includes Integrated farming system, technology adoption, water resources management, agronomic practices, involvement of professionals and creation of database etc.

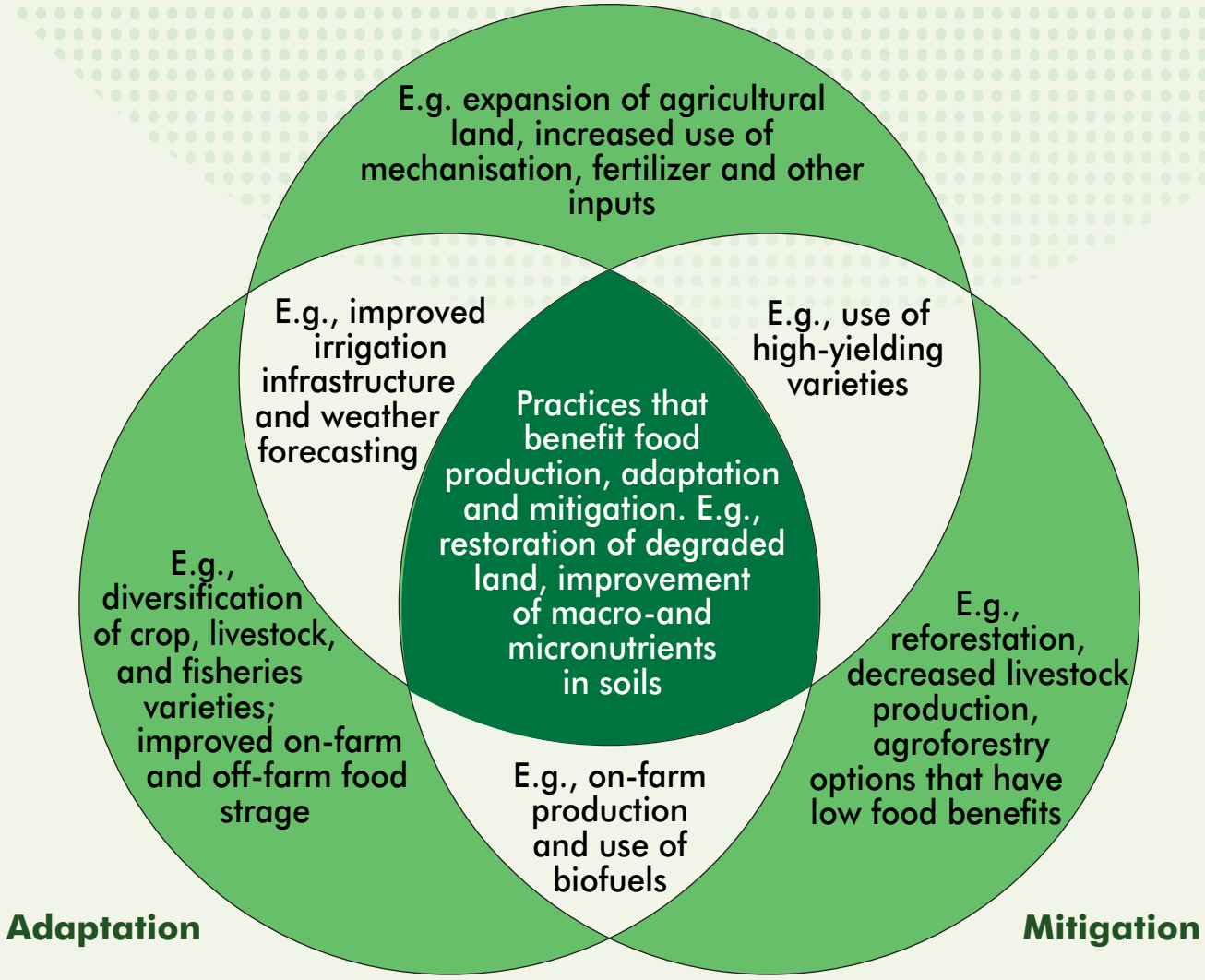
Mission Interventions

- **Rainfed Area Development (RAD):** RAD will adopt an area based approach for development and conservation of natural resources along with farming systems.
- **On Farm Water Management (OFWM):** OFWM will focus primarily on enhancing water use efficiency by promoting efficient on-farm water management technologies and equipment.

  Soil Health Management (SHM): SHM will aim at promoting location as well as crop specific sustainable soil health management including residue management, organic farming practices by way of creating and linking soil fertility maps with macro-micro nutrient management, appropriate land use based on land capability, judicious application of fertilizers and minimizing the soil erosion/degradation.
- **Climate Change and Sustainable Agriculture Monitoring, Modeling and Networking (CCSAMMN):** CCSAMMN will provide creation and bidirectional (land/farmers toresearch/scientific establishments and vice versa) dissemination of climate change related information and knowledge by way of piloting climate change adaptation/mitigation research/model projects in the domain of climate smart sustainable management practices and integrated farming system suitable to local agro-climatic conditions.

2. Climate Smart Agriculture

FAO defines CSA as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals".



3. Soil Health Card Scheme

Soil Health Card (SHC) is a printed report that a farmer will be handed over for each of his holdings. It will contain the status of his soil with respect to 12 parameters, namely N,P,K (Macro-nutrients); S (Secondary nutrient); Zn, Fe, Cu, Mn, Bo (Micro-nutrients); and pH, EC, OC (Physical parameters). Based on this, the SHC will also indicate fertilisers recommendations and soil amendment required for the farm.

Objectives of Soil Health Card Scheme

- To issue soil health cards to farmers every two years and provide a basis to address nutrient deficiencies in fertilization practices
- To develop and promote soil test based nutrient managements
- To develop and cultivation cost by application of right quality of fertilizer

  To ensure additional income to farmers by increase in yields
- To improve soil health for Sustainable Farming

SHC is provided to all farmers in the country at an interval of 2 years to enable the farmers to apply recommended doses of nutrients based on soil test values to realize improved and sustainable soil health and fertility, low costs and higher profits. Farmers can track their soil samples and also obtain their Soil Health Card report. It is a field-specific detailed report of soil fertility status and other important soil parameters that affect crop productivity.

Other Miscellaneous Steps

- Mandatory neem coating of urea since 2015 to reduce nitrous oxide emissions.
- Creating sustainable and climate-resilient agricultural systems is part of India's plan to meet pledge to the UNFCCC to reduce the emissions intensity of its GDP by up to 35% by 2030, compared to 2005 levels.
- India has installed 200,000 solar water pumps and another 2.5 million are planned to reduce emissions from energy use in agriculture.